1912

DIFFERENTIAL-PRESSURE TRANSMITTER

LEEDS & NORTHRUP

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SPECIFICATIONS

INPUT
Applied pressure of air or combustion products including water vapor, SO_2, CO_2, natural gas, coke oven gas, and similar fluids. (1/4" connections to high and low-pressure sides of diaphragm chamber.)

INPUT RANGE
As specified. Full-scale spans from 0.2 inch to 20 inches of water column are available (see Tables I and II).

OUTPUT-CURRENT RANGE
0 to 40 ma, 10 to 50 ma, or −20 to +20 ma d-c as specified (see nameplate).

LOAD RESISTANCE
0 to 300 ohms design load. (A ground is permissible at any point in the output circuit, but is not required.)

ACCURACY
±0.5% for under 6" span. ±1.0% for 6" to 20" span.

ELECTRICAL OUTPUT INDICATOR
Optional feature built into transmitter. Meter accuracy is 3%.

AMBIENT TEMPERATURE
0 to 160 °F normal operation. −30 to 160 °F extreme operating limits.

SPAN ADJUSTMENT
5% fine adjustment and 5:1 coarse adjustment.

ZERO ADJUSTMENT
0 to ±50% of span.

STATIC PRESSURE
0 to 50 psi.

RIPPLE IN OUTPUT
Less than 0.05% of 40 ma, peak-to-peak, any frequency.

VIBRATION LIMITS
0 to 0.5 g, 0 to 65 cycles per second.

DIAPHRAGM MATERIAL
Buna N coating on Dacron.

OVER-RANGE PRESSURE
15 psi maximum excess on the high pressure side.
9 inches water column maximum excess on low pressure side for Bands 1 and 2 (see Table I); 18 inches for Band 3; 60 inches for Band 4.
Higher over-range pressures may damage the transmitter.

POWER REQUIREMENTS
107 to 127 volts a-c line at 48 to 62 cycles. Maximum load 11 watts.

DIMENSIONS
8-1/2" x 8-1/2" x 15-1/8" high. (See outline and mounting dimensions in Fig. 2.)

WEIGHT
Approximately 30 pounds.

The nameplate, giving catalog number, serial number, range, and output signal for your transmitter, is mounted at the back of the damping magnet and can be read from the right side of the transmitter when the top cover is removed.

1912

DIFFERENTIAL-PRESSURE TRANSMITTER

PART I GENERAL INFORMATION

1. INTRODUCTION

The 1912 Differential-Pressure Transmitter is a precision instrument which measures the pressure or differential pressure of gases in industrial processes (including water vapor, SO_2, CO_2, natural gas, coke oven gas, and similar gases. It employs a force-balance type of measurement. A capacitor-detector and associated electronic circuits convert changes of differential pressure into changes of direct current over a 40 ma span. This current, which produces a magnetic feedback force in the force-balance system, constitutes the transmitter output, which may be carried by two wires to remote recording and control instruments without loss in accuracy so long as load plus line resistance does not exceed 300 ohms.

The transmitter, shown assembled in Fig. 1, is housed in a casting having three sections, the upper containing dual beam and magnet assemblies, the lower containing the electronics on a plug-in printed-circuit card, and the other compartment containing a diaphragm. Pressure is admitted to high and low pressure chambers in the latter compartment through piping at the bottom. All electrical connections are made through a cable connected at the bottom of the housing. Although not explosion resistant, the housing is gasketed dust-tight and weather proof. A meter, indicating output current, may be mounted inside the top cover with its scale visible through a window.

The four bands of input-pressure spans available are listed in Table I in Part III. The first suffix number in the catalog number indicates the band of spans available on that particular instrument.

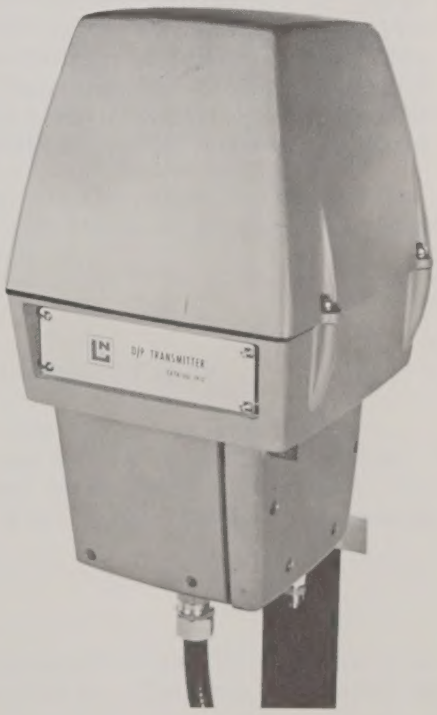


Fig. 1–The 1912 Transmitter assembled and mounted on a two-inch pipe.

2. FUNCTIONAL DESCRIPTION

Two pivoted vertical beams are the basis of the mechanical force-balance

system of measurement used. The flexible diaphragm on the right side of the lower section (Fig. 3) acts on the lower half of the vertical diaphragm beam. On the upper end of this beam is mounted the movable plate of an air capacitor (C22 Position Detector). A change in pressure between the high and low pressure chambers produces a change in force on the diaphragm, causing slight motion of the air-capacitor plate on the other end of the diaphragm beam. The resulting change of capacity is electronically converted to a change in the direct current which flows to the external load. This current also flows through the feedback coil on the lower end of the other pivoted beam, the coil beam, which is mounted adjacent to the diaphragm beam. See Fig. 4. The feedback coil is hung in the field of a permanent magnet and the coil current produces a field opposing the field of the magnet. Therefore, a change in output current tends to rotate the coil beam, which, in turn, rotates the diaphragm beam by means of a flexible link connecting the two beams. This change in output current causes the diaphragm beam to rotate in the direction opposite to the original rotation which produced the change at the position-detector capacitor. By this means, the force-balance system reaches an equilibrium for a particular output current, which is then an accurate indication of the force acting on the diaphragm as a result of the differential pressure applied. By means of this system, a very slight motion of the capacitor plates will change the output current over its full 40 ma span. A simplified sketch of this force-balance assembly will be found on the curve sheet Fig. 5. The single-turn coil on the upper end of the coil beam serves to magnetically damp the beam system as explained under Technical Information in Part V. A more comprehensive description of the operation of the beam-balance system, including the moments of force on each beam, is given in Section 21.

PART II INSTALLATION

3. UNPACKING

Carefully unpack the transmitter and follow the instructions on any tags which may be attached. All parts are in place when shipped. There are no shipping clamps used and no internal connections to be made; therefore, it is not necessary to remove any covers during the installation.

4. INSTALLATION REQUIREMENTS

The transmitter should be mounted in a location where the ambient temperature does not go below −30 °F or above 160 °F. Relative humidity should not exceed 100% at 100 °F, and vibration at the mounting surface should not exceed 0.5 g at 0 to 65 cycles per second.

Provide a power source of 120 volts, 50 or 60 cycles at a connection box at the transmitter site. The transmitter is supplied with a five-foot flexible conduit cable with mating connector.

The transmitter is suitable for bolting to a wall or, by using the U-bolts supplied, may be fastened to a vertical or horizontal 2-inch pipe as shown in Fig. 3. Mounting position has no effect on operation of the force-balance mechanism, but, to allow any condensate in the pressure chambers to drain out through the pressure taps, the transmitter should be mounted with the diaphragm vertical and the pressure connections at the bottom. For shipboard installations the front of the transmitter should be mounted to face either side of the ship because the output is less sensitive to front-to-back tilting than side-to-side tilting. For piping requirements, see Section 6 and Appendix A.

5. MOUNTING

Outline and mounting dimensions are shown in Fig. 2.

Note the clearances needed to remove the top cover and the electronic assembly. The transmitter is shipped with a mounting bracket attached, which may be removed and rotated 90 degrees if desired. To fasten the bracket to a two-inch pipe as in Fig. 3, use the U-bolts which are supplied.

6. PRESSURE LINE CONNECTIONS

Specific piping requirements and recommendations for various applications and conditions are given in Appendix A. General requirements and procedures are given here.

All pressure lines must be self-draining of condensate throughout their entire length, as very large errors are produced in any low-range

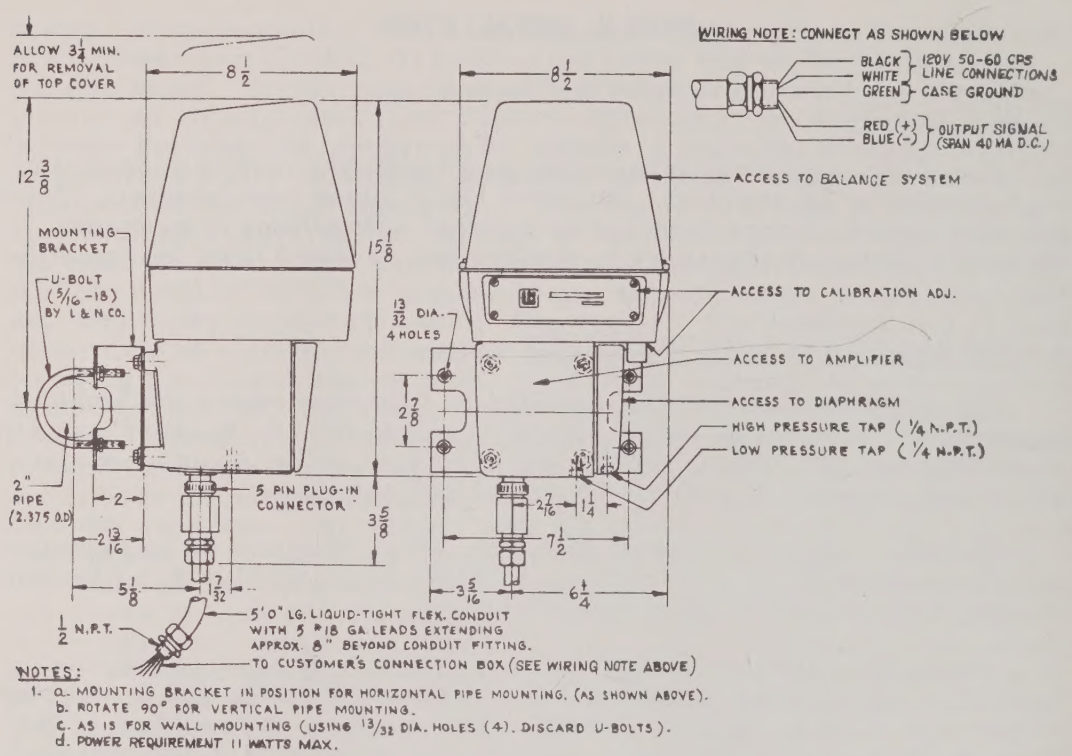

WIRING NOTE: CONNECT AS SHOWN BELOW
BLACK
WHITE
120V 50-60 CPS LINE CONNECTIONS
GREEN
CASE GROUND
RED (+)
BLUE (-)
OUTPUT SIGNAL (SPAN 40 MA D.C.)
ALLOW 3 1/4 MIN. FOR REMOVAL OF TOP COVER
8 1/2
8 1/2
12 3/8
15 1/8
ACCESS TO BALANCE SYSTEM
MOUNTING BRACKET
U-BOLT (5/16-18) BY L & N CO.
13/32 DIA. 4 HOLES
ACCESS TO CALIBRATION ADJ.
ACCESS TO AMPLIFIER
2 7/8
ACCESS TO DIAPHRAGM
HIGH PRESSURE TAP (1/4 N.P.T.)
LOW PRESSURE TAP (1/4 N.P.T.)
2" PIPE (2.375 O.D.)
2
5 PIN PLUG-IN CONNECTOR
3 5/8
2 13/16
2 7/16
1 1/4
7 1/2
5 1/8
1 7/32
3 5/16
6 1/4
1/2 N.P.T.
5'0" LG. LIQUID-TIGHT FLEX. CONDUIT WITH 5 #18 GA LEADS EXTENDING APPROX. 8" BEYOND CONDUIT FITTING.
TO CUSTOMER'S CONNECTION BOX (SEE WIRING NOTE ABOVE)
NOTES:
1. a. MOUNTING BRACKET IN POSITION FOR HORIZONTAL PIPE MOUNTING. (AS SHOWN ABOVE).
b. ROTATE 90° FOR VERTICAL PIPE MOUNTING.
c. AS IS FOR WALL MOUNTING (USING 13/32 DIA. HOLES (4). DISCARD U-BOLTS).
d. POWER REQUIREMENT 11 WATTS MAX.

Fig. 2–Mounting and dimensions drawing.

differential-pressure transmitter if liquid is permitted to collect and fill the cross-section of the tubing. (See Appendix A for recommended piping diagrams for self drainage.) In most applications, two pressure-line connections are necessary. Connect the high-pressure line to the outer hole (marked HP) on the bottom of the diaphragm-cover casting and the low-pressure line to the inner hole (marked LP) on the bottom of the main casting. Both holes are tapped 1/4" N. P. T.

Make certain that both pressure-line connections are tight and seal all joints with a suitable compound. A leak at the transmitter, process, or anywhere between will cause errors in measurement. To facilitate operation and checking of the transmitter, install a valve manifold between the transmitter and the process.

For straight pressure measurements, connect the pressure line to the outer hole (marked HP) on the base of the diaphragm-cover casting and leave the LP hole in the bottom of the main casting open to atmospheric pressure. If it is desired to avoid the effects of air turbulence around the transmitter on low-pressure measurements, a small hole, about 1/32" in diameter, may be drilled through the center of a pipe plug and the plug screwed into the low pressure tap in the main casting.

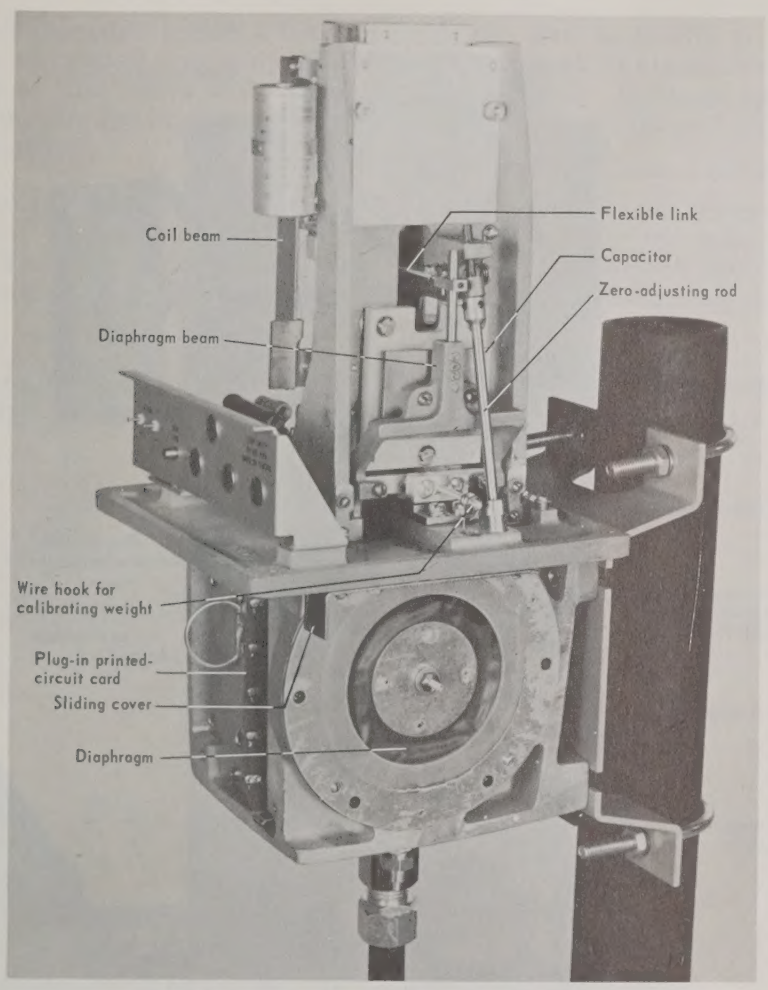


Fig. 3–Transmitter with cover casting and intermediate casting removed to show the diaphragm and diaphragm beam.

7. WIRING CONNECTIONS

There is no terminal board in the transmitter; all electrical connections are made through the five-pin connector at the bottom of the main casting. The mating connector is on a five-foot flexible-conduit cable which is supplied with each transmitter. Proceed as follows:

Install an electrical junction or terminal box within four feet of the transmitter. Fasten the end of the flexible conduit cable to this box, using the 1/2" conduit fitting on the cable. Inside the box, use a terminal board, solderless connectors, or other suitable means to make the following connections between the five wires of the cable and the plant wiring:

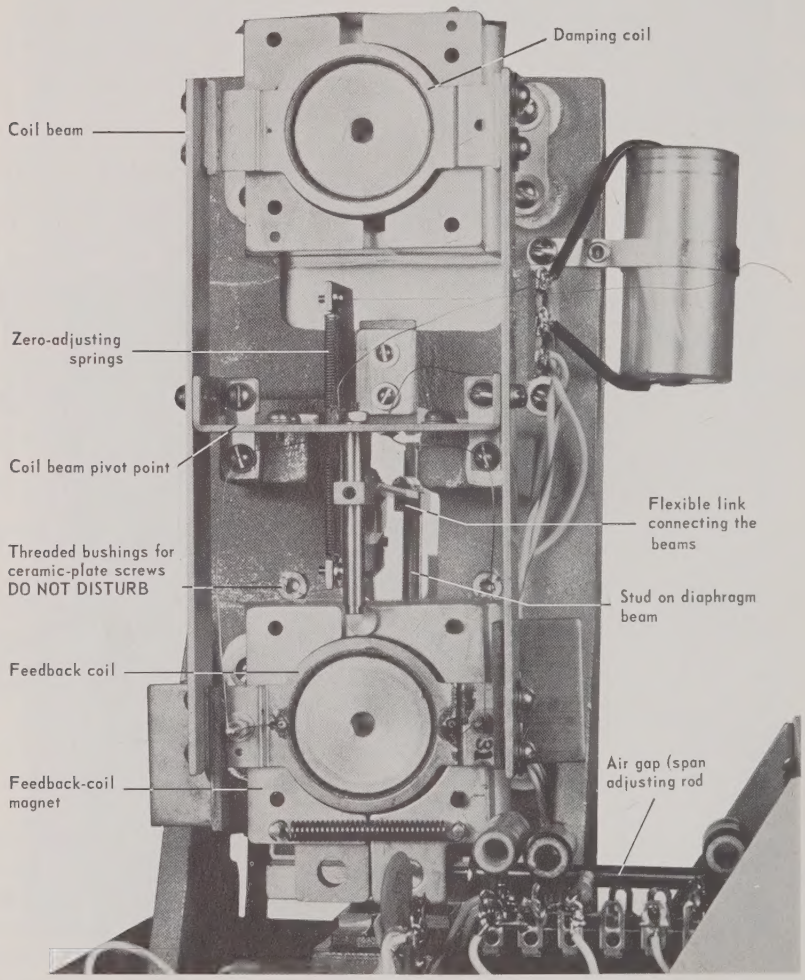


Fig. 4—The coil-beam assembly, showing the damping and feedback coils.

Black wire White wire	120 v line voltage supply
Green wire	ground
Red wire	+ output load
Blue wire	− output load.

For normal wiring runs from the junction box to the external load, the use of 22-gage copper conductors is satisfactory. For unusually long wiring runs, lead resistance becomes important because the total external resistance of the load plus the leads must not exceed 300 ohms. (See Specifications page.) Select the transmission wire size accordingly. For lead-resistance considerations in the special application where more

than one transmitter feeds a load resistance, see Appendix B. Note that an M-Line recorder and controller represent load resistances of 100 ohms each or 200 ohms when connected in series. Through proper selection of output resistance, any output voltage span from 0 to 12 volts may be obtained.

Ground the transmitter case through the green lead, connect the 120-volt line to the black and white leads and connect the external load to the red and blue leads (+ and −, respectively). Attach the cable connector to the transmitter and hand-tighten the retaining ring on the connector.

If piping connections have been completed, the transmitter is ready for operation. Energize the instrument by applying 120-volt a-c line voltage.

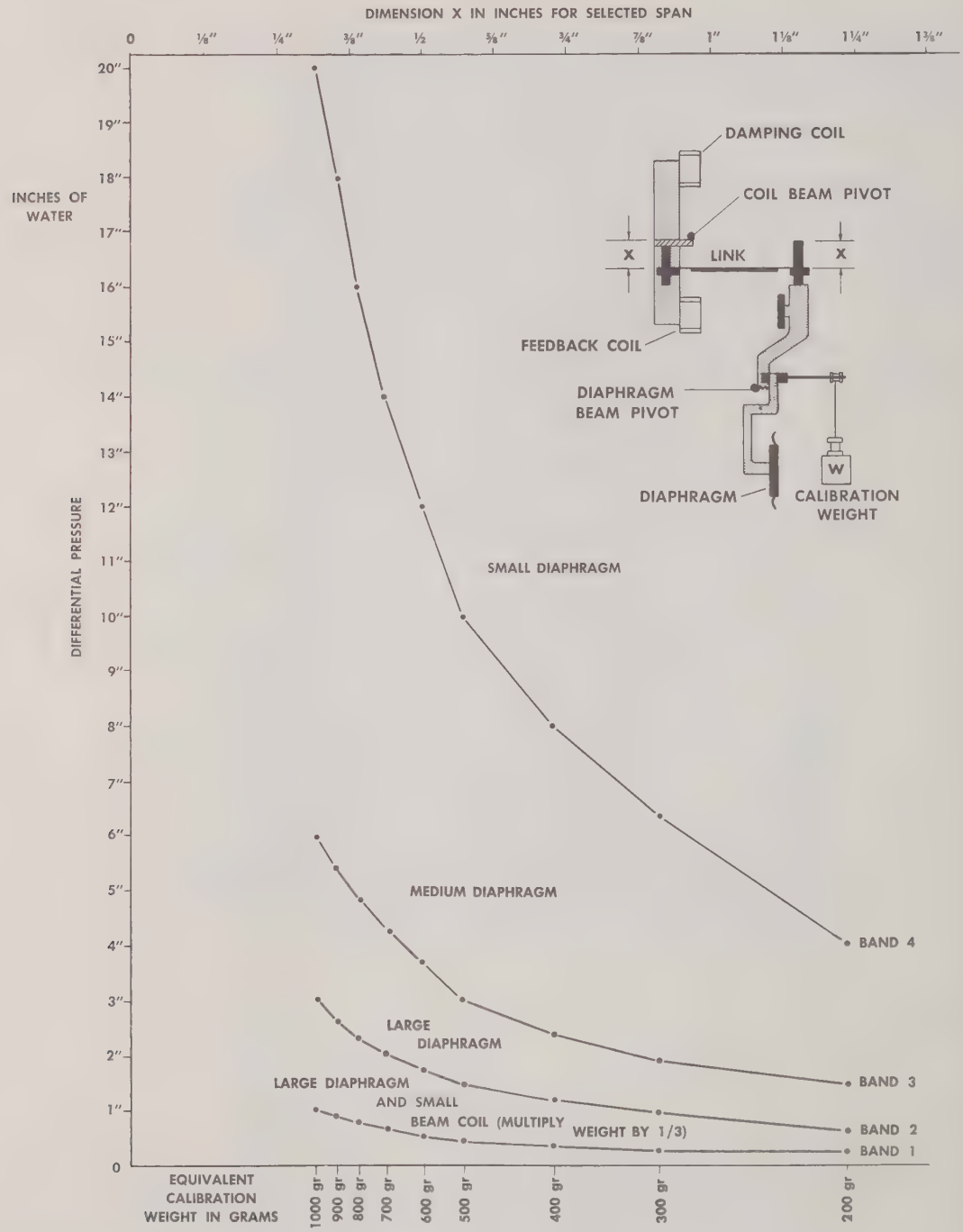


Fig. 5–Calibration curves for the four sensitivity bands and a mechanical diagram of the force-balance system during calibration.

PART III OPERATIONAL CHECKS, ADJUSTMENTS, AND STARTUP

These checks and adjustments are to be made after the transmitter has been installed as instructed in the preceding sections. They are necessary to place the transmitter in operation. The valves which are referred to are shown in the piping diagrams in Appendix A. The zero-adjusting rod and the hanger for suspending the weight for span calibration are accessible through holes under the ledge on the right side of the transmitter when the cadmium plate is pulled forward. (See Figs. 3 and 6.) Behind the nameplate on the front of the transmitter is located the one-ohm output-current calibrating resistor posts and the fine span adjustment. Span adjustments are based on the use of calibrating weights as shown in Fig. 5. Use a potentiometer such as the L&N 8696 (limit of error, 0.3% of range). To change the span of input pressure, make the coarse span adjustment given in Section 14. To change band, refer to Section 16.

8. ZERO-ENDED INPUT RANGE ADJUSTMENTS

8A. Check Zero Adjustment

(1) Open the bypass valve to equalize the two opposing pressures on the diaphragm; then close the blocking valves.

(2) Remove the nameplate by loosening the four captive screws; then measure the emf across the one-ohm resistor posts on the panel.

(3) If the measured output differs from the value specified for the low end of the output range* by more than ±0.2 millivolts, there may be some liquid entrapped in the lines or manifold.

If not, it may be necessary to adjust the zero by means of the adjusting rod accessible through the rear hole under the ledge on the right side. (See Fig. 3.) Slide out the cover under the ledge and use a screwdriver to adjust the output reading. Always approach the correct setting from a higher output reading by turning the adjusting rod counterclockwise. If either limit is reached, do not force the adjusting rod.

8B. Check the Span Setting

The transmitter input range span setting is checked by weight-loading the balance system with a standard gram weight corresponding to the upper limit of the input-pressure range. This weight-loading technique is shown on Fig. 5. The weight needed for any particular value of input pressure can be determined from Table I or from the curve sheet Fig. 5. The band number which applies to your instrument is identified

* This value depends upon the output range. It is zero for the 0 to 40 ma range, 10 mv for the 10 to 50 ma range, and minus 20 mv for the minus 20 to plus 20 ma range.

by the first suffix of the basic catalog number. The pressure column represents the equivalent range value of input pressure in inches of water column. Use the high-end value of the input range which, for zero-ended ranges, is the input span. For example, if your instrument is a 1912-3- and the range is 0 to 6 inches of water, the weight required (under Band 3) is 1000 grams. If the range were 0 to 4 inches, the weight required would be 667 grams.

(1) Find the high-end input-pressure value under the appropriate band heading of Table I. Then read the weight in grams, interpolating if the pressure value is not shown.

(2) Assemble this weight from a set of standard gram weights and hang the weight on the hook which is up inside the front hole under the ledge on the right side (Fig. 3). If necessary, accurately weigh out the required weight on a beam balance.

(3) With the correct weight loading the diaphragm beam in this way, the reading across the 1-ohm posts on the panel should be within ±0.2 millivolts of the voltage equivalent of the high end of the specified output range. (This is 40 mv, 50 mv, or 20 mv, depending on the range.)

(4) If the output reading differs from the appropriate value specified above, turn the fine span adjusting shaft with a screwdriver until the output is correct. Always approach the correct reading from below by turning the shaft clockwise. If a limit is reached, do not force the adjuster. A coarse span adjustment, given in Section 14, may be necessary.

(5) If the output range is 10 to 50 ma or −20 to +20 ma, the change of span setting requires a recheck of the zero in accordance with Section 8A. A change in the span setting may affect the output at zero pressure on these ranges; it will not affect the zero setting for the 0 to 40 ma output range.

(6) Remove the weight, slide the cover back over the holes, and replace the nameplate.

9. ELEVATED-ZERO INPUT-RANGE ADJUSTMENTS

9A. Check Zero Adjustment

(1) Close the blocking valves and open the bypass valve to equalize the two opposing pressures on the diaphragm.

(2) Remove the nameplate by loosening the four captive screws, then measure the emf across the one-ohm resistor posts on the panel.

(3) To determine the nominal output at zero pressure input, obtain a percent figure by dividing the low-end value of the input range by the span of the input range, then take this percentage of the output span and add it

to the low-end output current. For example: if the input range is −0.05" to +0.15" water, the span is 0.2" water. Therefore, .05/.2 = 25%. If the output range is 10 ma to 50 ma, the correct output current and its equivalent voltage across the 1-ohm resistor is 10 ma + 25% of 40 ma = 10 ma + 10 ma = 20 ma (a 20 mv check voltage). For a 0 to 40 ma output, the correct check voltage is 0 + 10 = 10 mv, and for −20 to +20 ma output, the voltage is −20 +10 = −10 mv.

(4) If the measured output at the one-ohm resistor differs from the value calculated above by more than ±0.2 millivolts, there may be some liquid entrapped in the lines or manifold. If the lines are clear, it may be necessary to adjust the zero by means of the adjusting rod accessible through the rear hole under the ledge on the right side. Slide out the cover under the ledge and use a screwdriver to adjust the output reading to the value calculated above. Always approach the correct setting from a higher output reading by turning the adjusting rod counterclockwise. If either limit is reached, do not force the adjusting rod.

9B. Check the Span Setting

Use Table I and the weight-loading technique described in Section 8B above to check the transmitter at the high-end value of the input pressure range. Find the required weight in the appropriate band of Table I. The first suffix of the catalog number is the proper band. Recheck the zero output.

10. SUPPRESSED-ZERO INPUT-RANGE ADJUSTMENTS

10A. Check Zero Adjustment

(1) Close the blocking valves and open the bypass valve to equalize the two opposing pressures on the diaphragm.

(2) Remove the nameplate by loosening the four captive screws; then measure the emf across the 1-ohm resistor posts on the panel.

(3) It is necessary to use the weight-loading technique to check the zero-output adjustment for a suppressed-zero input range. Find the weight which corresponds to the low-end value of the input pressure range in the appropriate band column of Table I. Interpolate if the pressure value is not shown. For example, if your instrument is a 1912-2- with a range of 1 to 3 inches of water, the weight required (found under Band 2) is 333 grams.

(4) Assemble the required weight from a set of standard gram weights and hang the weight on the hook which is suspended up inside the front hole under the ledge on the right side (Fig. 3). If necessary, accurately weigh out the required weight on a beam balance. When this weight loads the diaphragm beam, the voltage measured across the 1-ohm posts on the front panel should be within ±0.2 millivolts of the low-end value of the output range, 0 mv, 10 mv, or −20 mv.

(5) If necessary, adjust the zero by means of the adjusting rod accessible through the rear hole under the ledge on the right side until the output reading is correct.

10B. Check the Span Setting

The same technique is used to check span adjustment as was used to check the zero adjustment. This time, weight-load the balance system to the equivalent of the high-end value of the input pressure range. For example, if your instrument is a 1912-2- with a range of 1 to 3 inches of water, the weight required (found in Band 2 of Table I) is 1000 grams. Using this weight, the voltage measured across the 1-ohm posts on the front panel should be within ±0.2 millivolts of the voltage equivalent of the high end of the specified output range. (This is 40 mv, 50 mv, or 20 mv, for output ranges 0 to 40 ma, 10 to 50 ma, and −20 to +20 ma, respectively.) If the voltage measured is incorrect, turn the fine span adjusting shaft on the front panel with a screwdriver until the output is correct. Always approach the correct reading from below by turning the shaft clockwise. If a limit is reached, do not force the adjuster.

11. LEAK CHECK

Although the transmitter has been tested and is free of leaks when shipped, the user may desire to make these checks before startup. The following method requires the condition that both shutoff valves can be completely closed with no leakage around the valve seats. This method utilizes the transmitter as a sensitive leak detector. However, it is important to keep in mind that the transmitter can be severely damaged if the static pressure exceeds the over-range pressure limit on the low pressure side and a leak exists anywhere in the high-pressure line.

If the measured fluid is at a static pressure above atmospheric, proceed as follows:

(1) Close both shut-off valves and open both block valves and the bypass valve.

(2) Open the shut-off valve on the high-pressure side and close it again.

(3) Take a millivolt reading across the 1-ohm resistor and, while observing this reading, slowly close the bypass valve.

(4) If the millivolt reading starts to increase, there is a leak in the piping of the low-pressure line. If the millivolt reading starts to decrease, immediately open the bypass valve to avoid damaging the transmitter. This indicates a leak in the high-pressure line.

(5) Eliminate all leaks and retest. When the reading remains constant, the pressure lines are tight.

TABLE I–CALIBRATION DATA FOR THE 1912 TRANSMITTER

BAND 1			BAND 2			BAND 3					
PRESSURE inches of water column	X inches	WEIGHT grams	PRESSURE inches of water column	X inches	WEIGHT grams	PRESSURE inches of water column	X inches	WEIGHT grams	PRESSURE inches of water column	X inches	WEIGHT grams
00.00		0	00.00		0	00.00		0	00.00		0
00.05		17	00.05		17	00.50		83	00.50		25
00.10		33	00.10		33	01.00		167	01.00		50
00.15		50	00.15		50	01.20	1¼	200	01.20		60
00.20	1¼	67	00.20		67	01.50	1-1/16	250	01.50		75
00.30	29/32	100	00.30		100	02.00	27/32	333	02.00		100
00.40	23/32	133	00.40		133	03.00	37/64	500	03.00		150
00.50	37/64	167	00.50		167	04.00	15/32	667	04.00	1¼	200
00.60	½	200	00.60	1¼	200	05.00	3/8	833	05.00	1-1/16	250
00.70	7/16	233	00.70	1-3/32	233	06.00	5/16	1000	06.00	29/32	300
00.80	25/64	267	00.80	1	267	07.00		1167	07.00	13/16	350
00.90	11/32	300	00.90	29/32	300	08.00		1333	08.00	23/32	400
01.00	5/16	333	01.00	27/32	333	09.00		1500	09.00	41/64	450
01.50		500	01.50	37/64	500				10.00	37/64	500
			02.00	15/32	667				11.00	35/64	550
			03.00	5/16	1000				12.00	½	600
			04.00		1333				13.00	15/32	650
			04.50		1500				14.00	7/16	700
									15.00	13/32	750
									16.00	25/64	800
									17.00	3/8	850
									18.00	11/32	900
									19.00	21/64	950
									20.00	5/16	1000
									25.00		1250
									30.00		1500

NOTE: Dimension X in inches specifies the position of the flexible link connected between the two beams as shown in Fig. 4. It corresponds to the input-pressure span as read in the adjacent column.

If the measured fluid is at a static pressure which is near atmospheric pressure, proceed as follows:

(1) A static pressure is to be inserted into the system through an extra static pressure valve shown in the piping diagrams in Appendix A. First, close both shut-off valves and open both block valves and the bypass valve.

(2) Open the static pressure valve and introduce a static pressure of not more than six inches of water; then close the static pressure valve.

(3) Take a millivolt reading across the 1-ohm resistor and, while observing this reading, slowly close the bypass valve.

(4) If the millivolt reading starts to increase, there is a leak in the piping of the low-pressure line. If the millivolt reading starts to decrease, immediately open the bypass valve to avoid damaging the transmitter. This indicates a leak in the high-pressure line.

(5) Eliminate all leaks and retest. When the reading remains constant, the pressure lines are tight.

12. STARTUP PROCEDURE

The transmitter is ready for startup after calibration has been checked and piping is free of leaks. During startup take care to avoid

unnecessary shock or over-range. High over-range pressures may damage the transmitter.

(1) Open the bypass valve.

(2) Close both block valves. (If used, make certain that the static pressure valve is closed.)

(3) Open both shut-off valves.

(4) Slowly open both block valves.

(5) Close bypass valve.

(6) Transmitter is now in operation.

(7) Severe pulsation will affect the measuring accuracy of any differential pressure transmitter. The 1912 Transmitter has a fixed amount of internal magnetic and electrical damping. Its force-balance design requires very small volumetric displacement for its operation; therefore, pulsation dampers in the pressure lines would probably have little effect. The output signal may be damped by adding more capacity across the output load (a 250 μfd non-polarized electrolytic capacitor, C24, is connected internally). Note that the time constant for this method of damping varies as the product of capacity times total resistance in the output circuit. For example, if only a small output resistor is required (such as 1.25 ohms to feed a 50 ma H recorder) a 300 ohm padding resistor should be used in series with the 1.25 resistor to obtain maximum damping. An external non-polarized capacitor may be connected across the whole 301.25 ohms for additional damping. Capacitor voltage rating must be at least 12 V. Use several parts, —023136 (250 mfd, 25 V) or 023275 (1000 to 400 mfd, 18 V), as needed.

(8) The output circuits of the 1912 Transmitters allow some modifications from specified values of resistors without exceeding component ratings. To obtain maximum damping time constant with external damping capacitor for the 0-40 ma output circuit, shunt the 200 ohm padding resistor (R25) with another 200 ohm (shunted value 100 ohms) and pad up external load to 500 ohms (connect external damping capacitor across the whole 500 ohms). Internal 100 ohm pad is needed to prevent overloading power transformer if output terminals are shorted. If the full 500 ohm load is used, then the capacitor rating must be at least 20 V, for 40 ma output. For the 10-50 ma output circuit, the procedure is the same as for 0-40 ma circuit. Capacitor rating for 500 ohm load must be at least 25 V for 50 ma output. For the −20 to +20 ma output circuit, short out the 200 ohm padding resistor (R25) with wire jumper, and pad up external load to 400 ohms (connect external damping capacitor across the whole 400 ohms). No internal pad is needed. Since 20 ma flowing through 400 ohms drops only 8 volts, this is the minimum voltage rating for the damping capacitor.

PART IV MAINTENANCE AND SERVICING

13. GENERAL

13A. Precautions

Most of the screws in the transmitter are simply for mechanical assembly. However, the following parts must not be turned, as doing so will disturb the factory calibration of the transmitter.

—The three spring-loaded flat head screws holding the ceramic plate which supports the aluminum capacitor-detector plate.

—The three threaded brass bushings holding the above screws in the casting.

—The sixteen screws fastening the ends of the cross-spring hinges which support the two beams.

—The two nuts holding the pulley on the threaded weight-calibration rod.

—The three screws holding the brass-seal plate containing the O-ring low-pressure seal.

13B. Sensitivity-Adjustment Bands

The 1912 Differential-Pressure Transmitter can be provided with any one of four overlapping bands of sensitivity, each of which is adjustable over a range of 5 to 1. Table II indicates the limits of these ranges of adjustment in each band and also identifies the coil and diaphragm needed for that band. Sensitivity is based on full scale output of 40 ma and input pressure in inches of water. The reader can also observe the input spans available in a selected band. For example, in Band 1 the input pressure span can be as low as 0.2 inch of water or as high as 1 inch of water; in Band 4 the input pressure span can be adjusted from 4 inches of water to 20 inches of water.

14. COARSE (5:1) SPAN AND SENSITIVITY ADJUSTMENT (SPAN CHANGE)

When a sensitivity adjustment beyond the limit of the span-trim adjustment is required, the link between the two beams must be raised or lowered. Identified in Figs. 3 to 6, this link is a strip of metal, connected by a leaf-spring hinge strip at each end, to brass clamp blocks which can slide up or down on two parallel rods for position adjustment. (See Fig. 6.) The input pressure span is increased as the link is raised; its span is decreased when the link is lowered. The nominal position for this link is given in Table I and in Fig. 5 in terms of dimension X. Note that for purposes of determining the required dimension X, the pressure values in Table I must be considered as the span of input pressure range. If, after

TABLE II–SENSITIVITY BANDS WITH CORRESPONDING COIL AND DIAPHRAGM PART NUMBERS

BAND	SENSITIVITY		COIL	DIAPHRAGM
	maximum	minimum	resistance and part number	
1	40 ma/0.2 inch	40 ma/1 inch	3 ohms Part 115126	LARGE Part 133063
2	40 ma/0.6 inch	40 ma/3 inches	26 ohms Part 115125	LARGE Part 133063
3	40 ma/1.2 inches	40 ma/6 inches	26 ohms Part 115125	MEDIUM Part 133064
4	40 ma/4 inches	40 ma/20 inches	26 ohms Part 115125	SMALL Part 133065

All other parts used in the transmitters are identical.

the link is moved to a new position, the full-scale output is checked (using pressure or calibrating weight for full scale input) and found to be less than 100%, then the link must be lowered. If output is found to be more than 100%, the link must be raised.

Use the following procedure to change the coarse sensitivity setting.

(1) Turn the span trim adjustment one or two turns from its counter-clockwise limit.

(2) Loosen the setscrews in the clamps at each end of the flexible link, using a .050-inch Allen wrench. Move the clamps up or down their rods the same distance, keeping the link horizontal and being careful not to bend the two hinges. Tighten the setscrews to secure both clamps in their new positions. (The distance from the top of the right clamp to the upper end of its rod must equal the distance from the top of the left clamp to the upper surface of the bracket supporting this rod. See X on the sketch in Fig. 5.) Check to see that the coil beam is not touching the face of either magnet. If it is, perform Steps (1) and (3).

(3) With pressure equalized across the diapharagm, connect a potentiometer (L&N Cat. 8696 or equivalent) across the posts marked 1 ohm on the panel under the nameplate; make a reading and then adjust this reading to the millivolt equivalent (0, 10, or −20 mv) of the low-end value of the specified output-current range using the zero adjustment. If end value cannot be obtained, perform Steps (1) and (3).

(4) Find the weight corresponding to the new pressure input span which is being calibrated (see Table I) and hang this weight from the wire hook, Fig. 6.

(5) Again measure the transmitter output using the potentiometer. If

this output is less than the equivalent high-end output (40 mv, 50 mv, or −20 mv), the link is set too high. Unless the output can be raised to 100% output by turning the trimming adjustment, the link must be lowered. Then remove the weight, go back to step (1), and repeat this procedure.

(6) If the output is more than the high-end value (40 mv, 50 mv, or 20 mv) the link is set too low and must be raised. Then remove the weight, go back to step (1) and repeat this procedure.

(7) After the input pressure span has been correctly adjusted, the calibration procedure for a zero-based input pressure range is complete. If the desired range requires an elevated or suppressed zero, a further adjustment is necessary, as described below.

(8) To set an elevated zero range (e.g., −1 to +3 inches of water), calculate the output voltage which should be obtained for zero input-pressure. In this example, the pressure span is 4 inches of water and zero pressure is 25% above the low range value of −1 inch of water. The output at zero pressure should, therefore, be 10 mv for 0 to 40 ma output, or 20 mv for 10 to 50 ma output, or −10 mv for −20 to +20 ma output. Adjust the zero until the required output is obtained when the pressure is equalized across the diaphragm.

(9) To set a suppressed zero range (e.g., +1 to +5 inches of water), find the weight corresponding to the low range value (1 inch of water in this example) under the proper band column of Table I and hang this weight on the hook. Then adjust the zero until the specified low-end output is obtained (0 mv for 0 to 40 ma output, 10 mv for 10 to 50 ma output, and −20 mv for −20 to +20 ma output).

15. PRESSURE CALIBRATION OF TRANSMITTER

For this method of calibration, the span and zero adjustments are made in the same way as in the preceding method, applying air pressure to the diaphragm as the transmitter input instead of using standard gram weights as described above. However, certain precautions are necessary and these are listed below.

(1) In general, a vertical U-tube water manometer cannot be read accurately enough to measure differential pressures across the diaphragm. An inclined draft gage is better, but the primary pressure-measuring device recommended for use with this transmitter is a Merriam Micromanometer, which can be read to .001 inch of water. One each of the large and small size Merriam Variators (adjustable bellows) are also useful for making pressure settings.

(2) The tubing used to make pressure connections between the transmitter, Micromanometer and the two Variators must be free of leaks and free of moisture which might collect at a low point in the tubing, causing errors in pressure readings. Stiff-wall plastic tubing is more satisfactory than the flexible variety for minimizing external effects on pressure readings.

(3) Connect the low-pressure side of the transmitter directly to the low-pressure side of the micromanometer, and provide a single vent to atmosphere in this line to reduce the effects of local air turbulance on the transmitter output. For the lower-range transmitters (below 4 inches of water input pressure span), it will be found advisable to close this vent in the low pressure line to obtain more stable readings. If this is done, changing the pressure on the high pressure side will, at the same time, change the static pressure on the transmitter; but this has a negligible effect on its accuracy.

(4) If an elevated zero transmitter (such as −1 to +3 inches of water pressure range) is to be pressure calibrated, the negative pressure can be obtained by simply reversing the high and low pressure connections at the transmitter and applying a positive pressure to the low pressure side.

16. CHANGING THE DIAPHRAGM ASSEMBLY

The span desired may be beyond the limit of the coarse (5:1) span and sensitivity adjustment achieved by changing the height of the flexible link as described in Section 14. If so, it is necessary to replace the diaphragm assembly in accordance with the procedure described here. The four bands of input pressure spans available and the corresponding diaphragms are listed below:

Band 1	0.2" to 1" water-column span	Large diaphragm
Band 2	0.6" to 3" water-column span	Large diaphragm
Band 3	1.2" to 6" water-column span	Medium diaphragm
Band 4	4" to 20" water-column span	Small diaphragm

Replace the diaphragm assembly as follows:

(1) Disconnect piping from the HP pressure tap on the diaphragm cover.

(2) Remove the six socket-head screws from diaphragm cover. (The screw threads are lubricated and must be kept clean.)

(3) Pry off the diaphragm cover, using a large screwdriver. Pressure seal will break suddenly; be ready to catch cover when it falls. Keep seal surfaces clean.

(4) Hold end of threaded rod gently with gas pliers and loosen the nut at diaphragm center with an open-end wrench. Remove nut, washer, and seal-washer and save for reassembly. Do not allow the threaded rod to turn; this is adjusted for high pressure over-range stop.

(5) Remove four filister-head screws near outer edge of aluminum ring, and save.

(6) Hold knife blade at edge of aluminum ring where it is sealed to casting, and break seal by tapping on back of blade. (If this cannot be

done at the bottom of the casting, it may be necessary to remove the electronics cover and insert the blade at the front edge of the casting. To remove the electronics cover, back each of the four screws out one turn and then free the cover from the casting before loosening the screws all the way. The screws are captured and should not be removed from the cover.)

(7) Remove diaphragm assembly from casting.

(8) Scrape off any thick layers of gasket material which may be on the casting or the diaphragm cover. Remove from threaded and clearance holes any of this material which might interfere with positioning the new diaphragm assembly. Wipe the sealing surfaces of both castings clean.

(9) Spread a film of Plastic Gasket (a product of Loctite Corp., Newington, Conn.) over the low pressure sealing surface of the new diaphragm assembly. (The low-pressure side of the diaphragm assembly may be identified as the side with brass counter weight for the two smaller diaphragm assemblies, or the side with the heads of the round-head assembly screws for the largest diaphragm assembly.)

(10) Carefully slide the center hole of the diaphragm assembly over the hub on the beam, and press the outer ring against the casting. Rotate the outer ring to line up with the mounting holes, and position it to keep wrinkles in the flexible diaphragm to a minimum. Fasten in this position with the four filister-head screws (remove any old Plastic Gasket from screw heads before using them).

(11) Slide the sealing washer (with black seal around edge of hole) then the plain washer over the threaded rod, in that order, and fasten with a nut, being careful not to let the rod turn. Hold end of rod gently with gas pliers and tighten nut firmly against washers without turning rod.

(12) To check position of threaded rod, energize transmitter and measure the voltage across the posts marked 1 ohm resistor on the panel (behind name-plate) while pushing in on the center of the diaphragm as far as it will go. The output should read at least 125% of full scale (50 to 65 mv for 0 to 40 ma output range transmitter, 70 to 85 mv for 10 to 50 ma output, and 30 to 45 mv for −20 to +20 ma output). If it does not, loosen the nut and rotate the threaded rod while pushing the end of the rod against the casting until the above output is read. Lock the rod in this position by tightening the nut.

(13) Spread a film of Plastic Gasket over the sealing surface of the diaphragm cover casting, place the cover over the diaphragm, insert the six socket-head screws and tighten in rotation, uniformly, with a standard-length Allen wrench.

(14) Allow 3 to 4 hours for the Plastic Gasket to harden before applying pressure to the transmitter.

(15) Check zero and span adjustment and, if necessary, recalibrate.

17. CHANGING THE BEAM COIL

For a change of input pressure span from Band 1 to any other band (or vice-versa) it is necessary to replace the feedback coil at the lower end of the coil beam. The specific coil required for each band is listed in Table II. Change the beam coil as follows:

(1) Before removing the old coil, note the location of its mounting ears relative to the two side plates of the beam. The left-to-right position of the coil, viewed from the front of the transmitter, affects the center of gravity of the beam assembly; the up-and-down position and mounting angle affect its clearance in the magnet gap. The new coil should be fastened as nearly as possible, in the same position as the old coil.

(2) Using a small soldering iron, carefully remove the wires from the two terminals of the coil and bend them up out of the way. Do not apply too much heat.

(3) Remove the two screws on each side of the coil and the two brass counterweights. Slide the coil out of the magnet gap and remove from the beam.

(4) Note that the new coil has a small hole beside one of the terminals. This is a d-c polarity mark. Slide the new coil between the side plates and into the magnet gap, making certain that the terminal next to the hole is toward the rear of the transmitter.

(5) Replace the counterweights and loosely fasten the four screws. Position the coil where the old one was and be sure it will move in the magnet gap without rubbing or sticking. Tighten all four screws.

(6) Solder the wires on the two terminals. Check for no rubbing by removing the screw attaching the hinge strip to the clamp block at the right, diaphragm-beam, end of the link shown in Fig. 6. Then push the coil beam to the face of each magnet and observe that it comes away from the magnet by itself. Replace the screw and follow the procedure of Steps 18(1) and 18(3).

18. ADJUSTING THE LENGTH OF THE FLEXIBLE LINK

If one of the hinge strips of the flexible link between the two beams becomes bent and must be replaced, or if one of the four screws of the link becomes loose, or if the beam studs are not parallel and a coarse range change is attempted, or if there is insufficient zero adjustment, it is necessary to readjust the length of the link. Use the following procedure:

(1) Turn the zero adjuster shaft until the two zero springs are stretched equally. The edge of the zero bracket parallel to the zero springs should be approximately vertical.

(2) If the only screws which are loose or must be loosened are at the right (diaphragm-beam) end of the link, it will not be necessary to remove the entire link, and the reader may go directly to step 3.

If one or both screws which fasten the hinge at the left (coil-beam) end of the link are loose or must be loosened, it will be necessary to remove the entire link assembly from the transmitter. To do this, first remove the screw that fastens the hinge at the right (diaphragm-beam) end, being careful not to lose the small lockwasher and copper washer. Then use an open-end wrench to remove the hex nut that secures the upper end of the rod supporting the clamp at the other (coil-beam) end of the link. See Fig. 4. Slip this rod out of the hole in the center plate of the coil beam and remove the rod and link assembly. If necessary, replace one or both hinge strips and/or tighten the three screws, holding the link on its side on a flat surface so that its parts are straight. Replace the rod and tighten the nut, making certain that the hinge strip at the right (diaphragm-beam) end is lined up with the hole in the clamp on the diaphragm beam. Replace the copper washer, lockwasher, and screw in that order, and lightly tighten the screw.

(3) With all hinge screws tight except the one in the clamp block at the right (diaphragm-beam) end of the link (Fig. 6) equalize the pressure across the diaphragm. Transmitter output should be zero, 10 mv, or −20 mv according to the output range used. If output is low, lengthen the link by tapping the top of the diaphragm beam away from the casting. If output is high, tap lightly on the brass clamp to shorten the link without twisting the hinge strip. Tighten the single loose screw when output is within 0.2 mv of the correct value.

(4) Check and, if necessary, readjust the zero.

19. TROUBLESHOOTING

19A. General

The use of a printed circuit and solid-state components in the electronic circuits of this transmitter will assure extensive trouble-free performance. But if a failure is traced to a faulty oscillator, amplifier, or power supply, merely pull out the printed-circuit assembly and replace the entire assembly with a spare. This will restore and maintain service while the suspected fault is located by bench tests. The defective assembly can then be serviced and used as a spare. To remove the electronics cover, back off each of the four screws one turn; then free the cover from the casting before loosening the screws. These screws should not be removed. Then loosen two screws at the top and one screw at the bottom of the plug-in electronic assembly. A wire handle permits easy removal. Note that Test Point 5 at the top of the printed-circuit card may be at a potential as high as 93 volts d-c to ground. Therefore, always remove the plug-in cable before removing the chassis to avoid damage to equipment or personnel.

19B. Circuit Tests

When the cover is removed, the five test points of the electronic assembly are readily accessible on the front of the printed-circuit card.

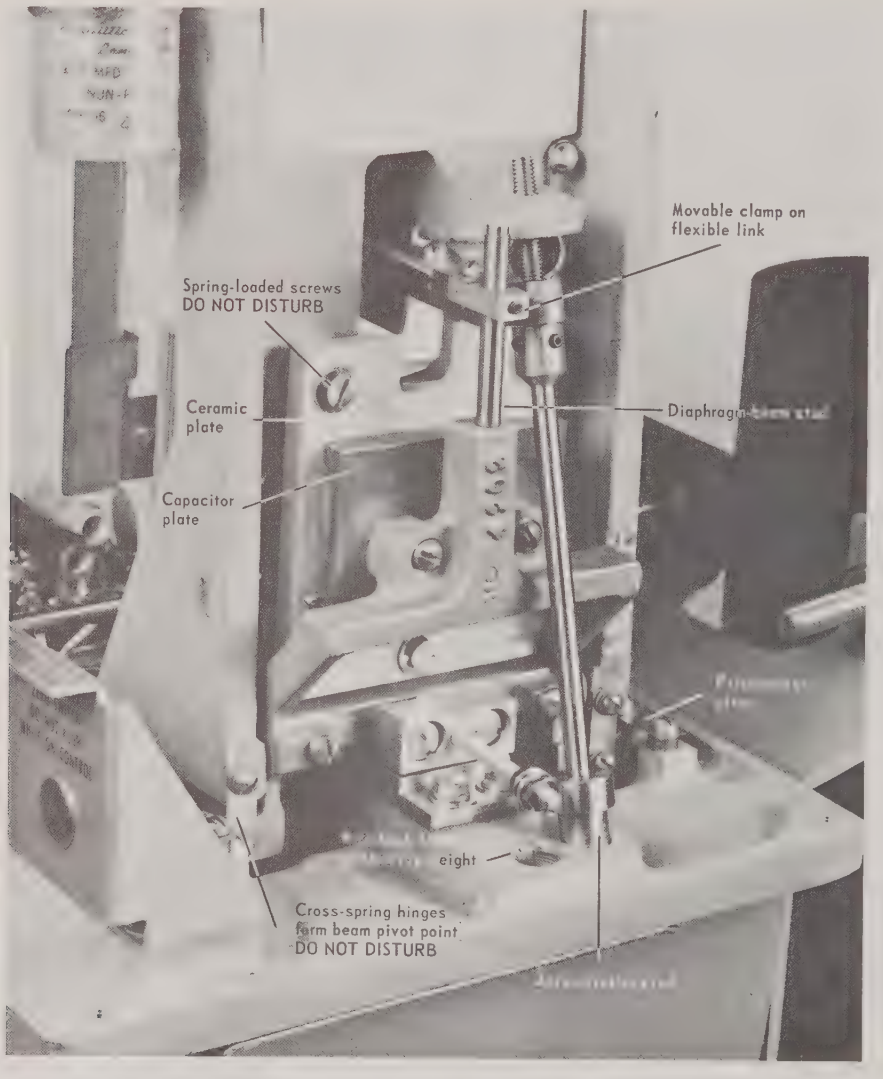
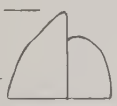

Movable clamp on flexible link
Spring-loaded screws DO NOT DISTURB
Ceramic plate
Capacitor plate
Cross-spring hinges form beam pivot point DO NOT DISTURB

Fig. 6—Close-up view of the diaphragm beam assembly pointing out certain critically adjusted parts.

These are identified on the circuit diagram, Fig. 7, as TP 1 to TP 5. All test-point voltages are measured with respect to TP 4. Proceed as follows:

Leave the assembly plugged in and the power applied. Use a Simpson Model 260 or equivalent 20,000 ohms-per-volt meter for making the voltage checks. To obtain the waveform shown for TP 2, use an oscilloscope with an X10 attenuator probe.

TABLE III–VOLTAGE CHECKS

TEST POINT	NORMAL INDICATION	PROBABLE CAUSE OF ABNORMAL INDICATION
TP 1	+8.6v to +9.6v	Defective Zener diode CR1.
TP 2	+3v ___ typical trace  +1v	A component in the oscillator circuit is probably defective.
TP 3	−.5v to −.8v at balance.	The screws on the position-detector capacitor may have been touched. Also check the Q2 circuit.
TP 5	+47v to +93v varies with current output and line voltages.	Check line voltage. A component in the power supply, from C8 to the transformer may be defective.

Clamp one of the meter leads to TP 4 and use a probe on the other lead to measure the voltage on each point in accordance with Table III.

19C. Printed-Circuit Component Replacement

When necessary to replace a component on a printed-circuit card, use a small-tip, low-wattage (40 to 50 watts) soldering iron to unsolder the component from the foil side of the card. If the part is to be discarded, first clip the leads on the component side of the board. Before removing a semiconductor, verify the polarity and marking to insure proper installation. When applying heat to a semiconductor, use a heat sink, such as long-nose pliers, on the lead.

Apply heat to both the lead and the hole. When the solder has melted, pull the lead from the hole. Work quickly to prevent heat from loosening the foil; but do not attempt to remove the wire before it is unsoldered as this could cause the foil to peel off. If a suction-type solder-removing device is available, place the soldering iron on the lead and remove the molten solder from around the lead. (Such a device is The Little Joe Excess Solder Remover, SR-25, Mills Equipment Company.)

Clean and tin the leads of the replacement component, bend them carefully according to the dimensions and insert them through the holes. Bend each lead slightly on the foil side and cut off the excess wire. Cut the leads long enough to overlap the circuitry on the foil side by 1/16 inch. Transistor leads should not be longer than 3/4 inch.

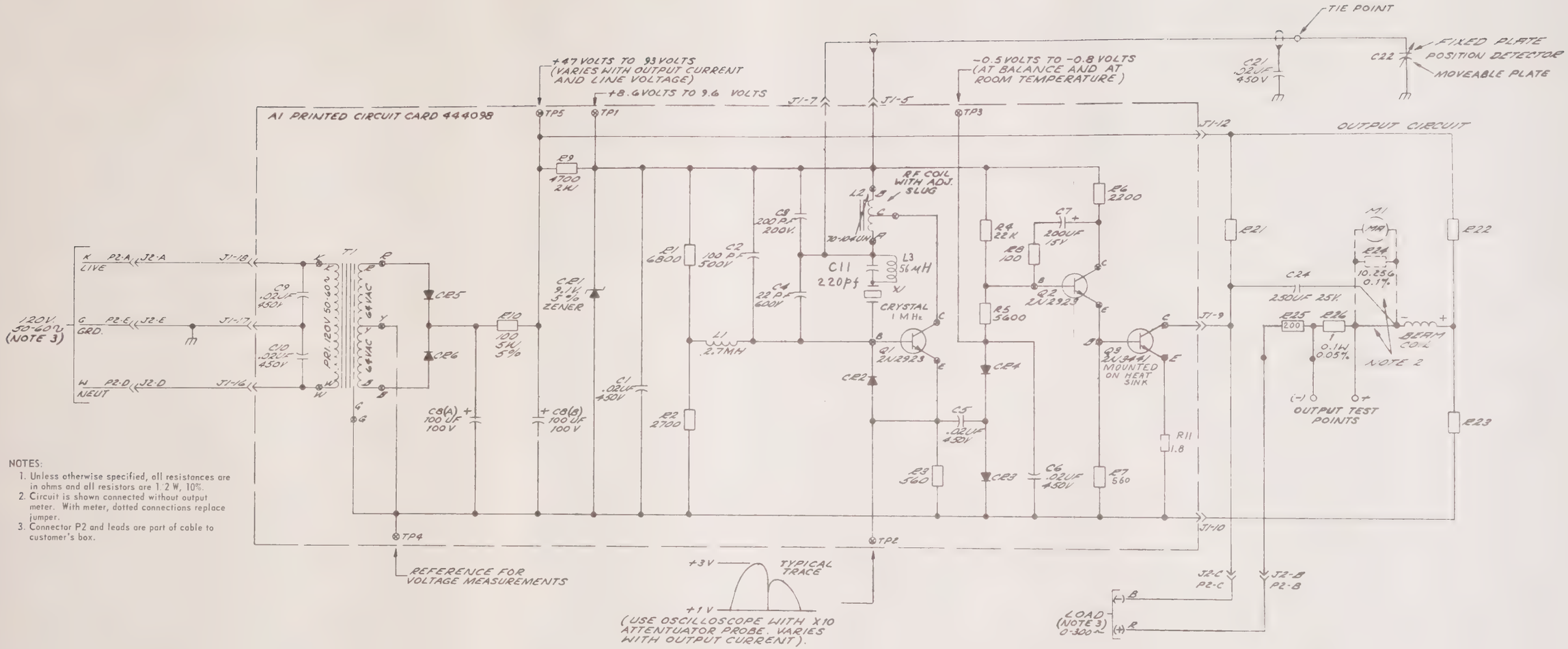
Apply heat and solder to the holes but do not overheat the board. Use a 40-60 tin-lead solder with rosin core. The soldered joint should not be more than 1/16 inch above the card surface.

20. RECOMMENDED SPARE PARTS

Recommended spare parts for the 1912 Differential-Pressure Transmitter are listed below.

QUANTITY	DESCRIPTION	PART NO.
1	Printed-Circuit Assembly	444098
1	Plug-in Cable Assembly for bench testing	237104
2 oz	Loctite Plastic Gasket Sealant* (for sealing diaphragm)	- - -
5	Hinge Strips	028320
10	Copper Washers	301034
2	Zener Diodes	188032
2	Diaphragm Seal Washer	096333
2	Diaphragm Washer	301025
1	Diaphragm	See Table II

* Obtain locally or from Loctite Corp., Newington, Conn.



NOTES:

1. Unless otherwise specified, all resistances are in ohms and all resistors are 1.2 W, 10%.
2. Circuit is shown connected without output meter. With meter, dotted connections replace jumper.
3. Connector P2 and leads are part of cable to customer's box.

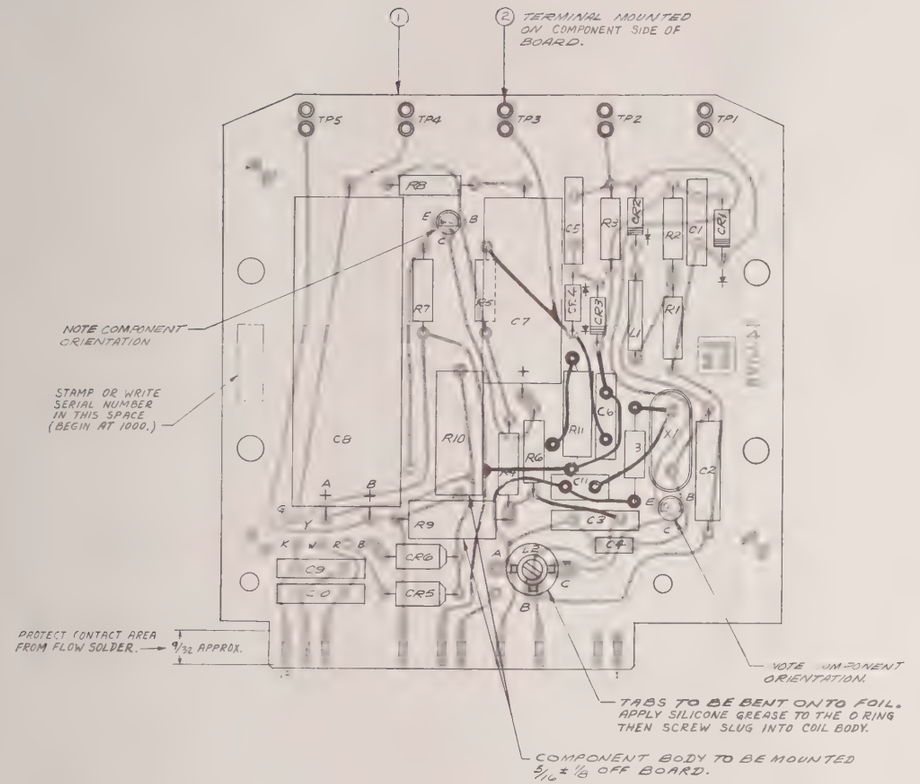
BEAM COILS

COPPER BEAM COIL	RESISTANCE (APROX) AT 25°C
STANDARD	27
LOW RANGE	1.7

OUTPUT-CIRCUIT RESISTORS

	0-40 MA	10-50 MA	-20 TO +20 MA
R21	1500 5W 5%	2500 5W 5%	700 10W 5%
R22	400 10W 5%	250 10W 5%	700 10W 5%
R23	2500 5W 5%	3K 5W 5%	400 10W 5%
R25	200 8W 5%	200 8W 5%	200 8W 5%

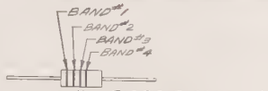
Fig. 7–Complete circuit diagram for the 1912 Differential Pressure Transmitter.


1
2 TERMINAL MOUNTED ON COMPONENT SIDE OF BOARD.
TP5
TP4
TP3
TP2
TP1
NOTE COMPONENT ORIENTATION
STAMP OR WRITE SERIAL NUMBER IN THIS SPACE (BEGIN AT 1000.)
PROTECT CONTACT AREA FROM FLOW SOLDER.
9/32 APPROX.
NOTE COMPONENT ORIENTATION.
TABS TO BE BENT ONTO FOIL. APPLY SILICONE GREASE TO THE O RING THEN SCREW SLUG INTO COIL BODY.
COMPONENT BODY TO BE MOUNTED 9/16 ± 1/8 OFF BOARD.

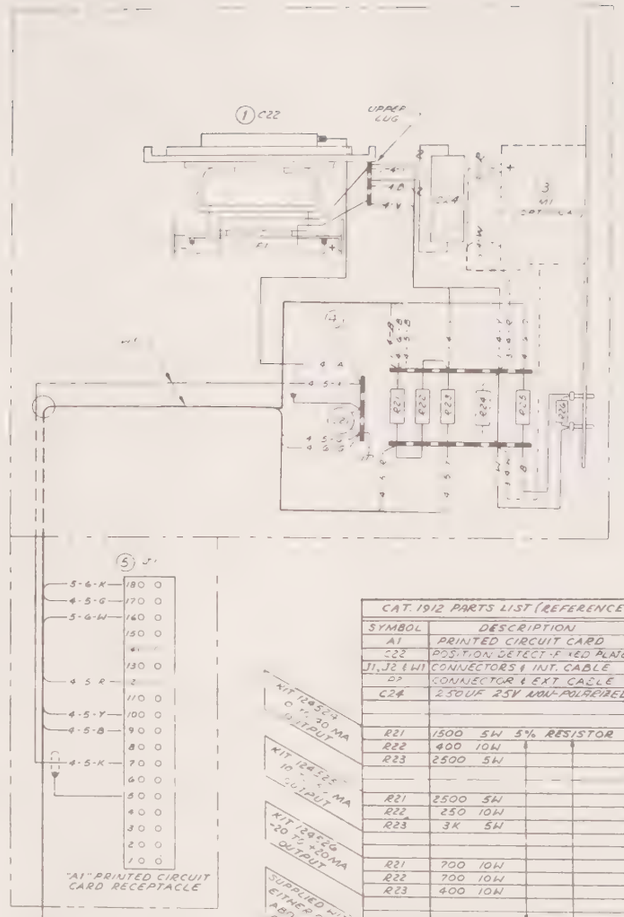
L2 RF. COIL DEVELOPMENT (TOP VIEW)
CENTER TAP
ADJUSTABLE SLUG LOCKED WITH PLASTIC SLASHER (FACTORY ADJUSTMENT)
Q1 & Q2 TRANSISTOR DEVELOPMENT (BOTTOM VIEW)
Q3 TRANSISTOR DEVELOPMENT (BOTTOM VIEW)

Fig. 8–Chassis wiring diagram, printed-circuit assembly 444098, and component parts list for 1912 Differential Pressure Transmitter.

		47				
		46	*	——	18,19	GREASE SILICONE DC-4
		45				
—	X1	44	1	171022	——	CRYSTAL (IMC)
		43				
	L3	42	1	019607	——	R.F. CHOKE 56 μh
—	L2	41	1	019330	——	INDUCTOR 70-104 μh
A	L1	40	1	019360	——	RF. CHOKE 2.7 MH
		39				
		38				
H	Q2	37	1	18811	——	TRANSISTOR 2N2923
H	Q1	36	1	8817	——	TRANSISTOR 2N2923
		35				
	C11	34	1	023561	——	CAPACITOR 220 pf 300 WVDC
—	C10	33	1	043096	——	CAPACITOR .02 μf 450 WVDC
—	C9	32	1	023096	——	CAPACITOR .02 μf 450 WVDC
G	C8	31	1	023499	——	CAPACITOR 100+100 μf 100 WVDC
E	C7	30	1	023522	——	CAPACITOR 200 μf 15 WVDC
—	C6	29	1	023096	——	CAPACITOR .02 μf 450 WVDC
—	C5	28	1	023096	——	CAPACITOR .02 μf 450 WVDC
—	C4	27	1	023452	——	CAPACITOR 22 pf 500 WVDC
—	C3	26	1	021517	——	CAPACITOR 2.0 PF 500 WVDC
E	C2	25	1	023137	——	CAPACITOR 100 PF 500 WVDC
—	C1	24	1	023096	——	CAPACITOR .02 μf 450 WVDC
		23				
		22				
D	CR6	21	1	057065	——	RECTIFIER IN2070
D	CR5	20	1	057065	——	RECTIFIER IN2070
C	CR4	19	1	188356	——	DIODE IN914
C	CR3	18	1	188356	——	DIODE IN914
C	CR2	17	1	057046	——	RECTIFIER IN4824
C	CR1	16	1	188332	——	DIODES ZENER IN757A
		15				
		14				
B	R11	13	1	011111	11-1-0-11	RESISTOR 1.8Ω 1/2W
—	R10	12	1	011043	——	RESISTOR 100Ω 5W
B	R9	11	1	011305	11-3-0-52	RESISTOR 2,700Ω 1% 1/2W
A	RB	10	1	011132	11-1-0-32	RESISTOR 100Ω 1/2W
A	R7	9	1	011141	11-1-0-41	RESISTOR 560Ω 1/2W
A	R6	8	1	011148	11-1-0-48	RESISTOR 2,200Ω 1/2W
A	R5	7	1	011153	11-1-0-53	RESISTOR 5,600Ω 1/2W
A	R4	6	1	011160	11-1-0-60	RESISTOR 22,000Ω 1/2W
A	R3	5	1	011141	11-1-0-41	RESISTOR 560Ω 1/2W
A	R2	4	1	011149	11-1-0-49	RESISTOR 2,700Ω 1/2W
A	R1	3	1	011154	11-1-0-54	RESISTOR 6,800Ω 1/2W
		2	10	016178	——	TERMINAL
		1	1	144259	——	PRINTED CIRCUIT BOARD
FIG.	SYMBOL	DET.	QTY.	PART OR DWG NO.		DESCRIPTION



PART NO.	BAND COLOR			
	1	2	3	4
188332	PURPLE	GREEN	PURPLE	BROWN
188356	WHITE	BROWN	YELLOW	—
057046	YELLOW	GRAY	RED	—



CAT. 1912 PARTS LIST (REFERENCE ONLY)			
SYMBOL	DESCRIPTION	PART NUMBER	
A1	PRINTED CIRCUIT CARD	444098	
C22	POSITION DETECT-F "ED PLATE	249096	
J1, J2 & W1	CONNECTORS & INT. CABLE	128373	
P2	CONNECTOR & EXT CABLE	237104	
C24	250 UF 25V NON-POLARIZED	023136	
R21	1500 5W 5% RESISTOR	011078	11-12-0-2
R22	400 10W	311175	
R23	2500 5W	011914	
R21	2500 5W	011914	
R22	250 10W	311272	
R23	3K 5W	311273	
R21	700 10W	311176	
R22	700 10W	311176	
R23	400 10W	311175	
R25	200 8W 5%	311328	
R26	1 1W .05% RESISTOR	010982	
C21	.02 UF 450V CAPACITOR	023096	
F1	STD. FEEDBACK COIL - 2Ω	115125	
F1	LOW RANGE FDBK. COIL - 3Ω	115126	

KIT 124528 0"-30 MA OUTPUT

KIT 124525 10"-50 MA OUTPUT

KIT 124526 "20 TO 120 MA OUTPUT

SUPPLIED WITH EITHER OF THE ABOVE THREE PARTS KITS

FEEDBACK COILS

KIT 124528 METER ASSY PARTS LIST (REF. ONLY)			
SYMBOL	DESCRIPTION	PART NUMBER	
R24	10.256 1/2W .1% RESISTOR	011719	
	METER LEADS PAIR	237103	
M1	METER	021055	
M1		021095	NST
M1	METER	021094	NST

0"-30 MA

10"-50 MA

-20 TO +20 MA

PART V TECHNICAL INFORMATION

21. THE FORCE BALANCE SYSTEM

21A. Theory of Operation

Figure 9 is an electromechanical schematic of the transmitter to which the following notation applies. The notation also applies to electrical components shown in the schematic wiring diagram, Fig. 7.

The process pressures P_L and P_H are admitted at the bottom of the transmitter to opposite sides of the vertical slack diaphragm.

The input force F_D from the diaphragm multiplied by the 3 inch distance from the diaphragm center to the diaphragm beam pivot, must be balanced by the connecting link force F_L times its distance to the diaphragm beam pivot (4.5 – x). Notice that (P_H – P_L) is the differential pressure input. F_D is d/p input times diaphragm area. The following equation represents the relationships:

$$F_D = \frac{\pi d^2}{4} (P_H - P_L).$$

If the diaphragm beam is not in equilibrium, it moves and changes the capacity of the air capacitor position detector C22. The change in capacitor C_{22} changes the amplitude of oscillation in the oscillator circuit (C_{21}, C_{22}, L_2, X_1, Q_1), which is regulated by the 1 megacycle crystal X1. After rectification this amplitude change appears on C6 as a change in the input voltage to the d-c amplifier.

The amplified d-c voltage change is applied to output transistor Q3 and changes its effective collector-to-emitter resistance. The output bridge is balanced only at zero output current. A change in the resistance of Q3 changes the unbalance current between 1 and 2 across the bridge. This unbalance current is the output current of the transmitter and flows through both the 1-300 ohm load resistance and the feedback coil (or coils in the case of the flow transmitter).

The output current change through the feedback coil produces a change in the magnetic field of the coil. The change in coil field opposes the field of the magnet gap, developing a change in the feedback force F_C. This change in F_C times its 2.5 inch moment arm is converted to the change in the connecting link force F_L times its moment arm X, so that $\frac{2.5\, F_C}{X} = F_L$ is applied to the upper end of the diaphragm beam at moment arm (4.5 – X) above its pivot, so as to re-establish equilibrium of the diaphragm beam at (very nearly) the original balance position. The balance equation for the diaphragm beam is therefore $(4.5 - X)F_L = 3\, F_D$.

The resulting equation relating the force on the coil to the force on

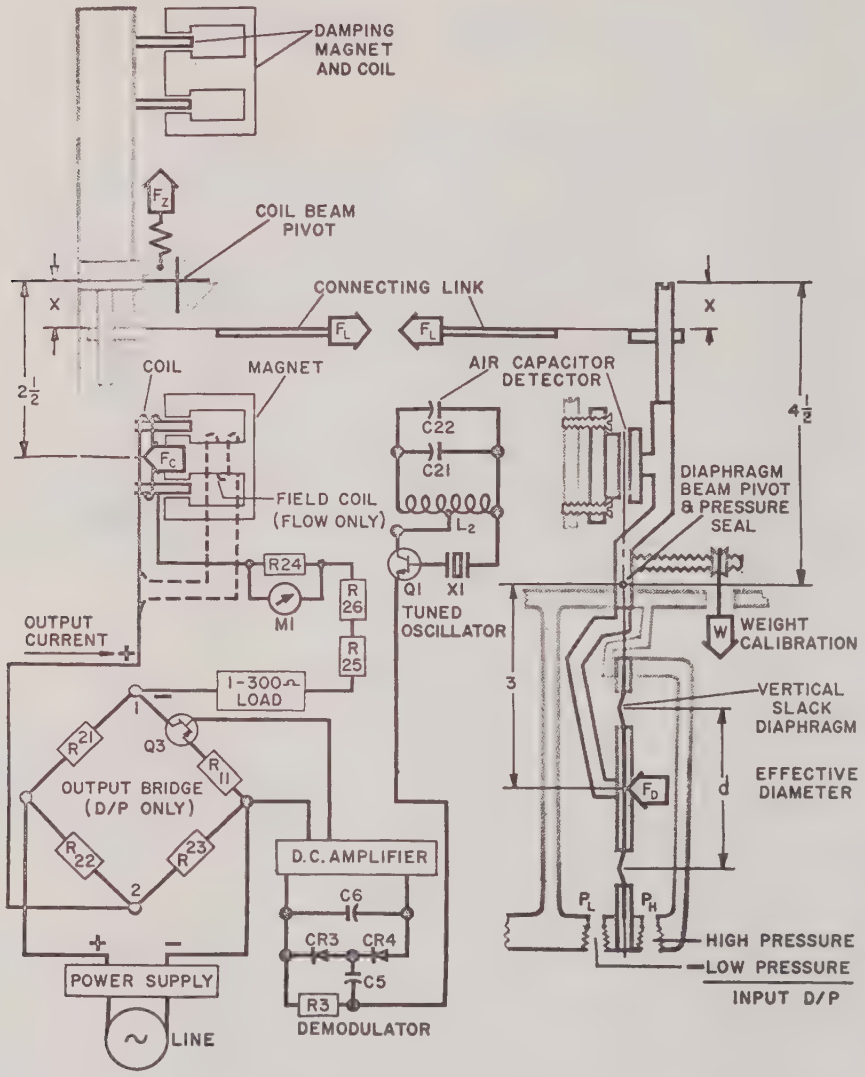


Fig. 9—Schematic diagram of the moments of force acting in the beam-balance system.

the diaphragm is $F_C = F_D \frac{3X}{2.5\,(4.5 - X)}$. The coils and magnets are designed to make F_C = 40 grams with 40 ma output current in the standard coils, and F_C = 13.3 grams with 40 ma output current in the low range coils.

By adjusting the distance X, between 9/32 and 1-1/8 inches, a 5:1 coarse sensitivity adjustment is achieved. A 5% fine sensitivity adjustment is accomplished by changing the air gap of the magnet and thereby changing the field strength in the gap. Widening the air gap causes an increase in output current, since a weaker field requires a higher current to produce a given force.

TABLE IV–FORCES ACTING ON DIAPHRAGM BEAM

Sensitivity Adjustment Band	Pressure Span		Diaph. Diam. Inches	Diaph. Area Sq. In.	Diaph. Force Grams	Torque Gram-In.	Wt. Cal. Grams
	Inches Water	Grams per Sq. Inch					
1	0.2-1.0	3.28-16.4	3.60	10.16	33.3-167	100-500	67-333
2	0.6-3.0	9.84-49.2	3.60	10.16	100-500	300-1500	200-1000
3	1.2-6.0	19.7-98.4	2.54	5.08	100-500	300-1500	200-1000
4	4-20	65.6-328	1.39	1.52	100-500	300-1500	200-1000

The feedback force is proportional to the output current i, the length of wire on the voice coil l, and the field strength in the magnet gap Φ ($F_C = K\Phi li$). In the case of the Cat. 1912 d/p transmitter the field strength is supplied by an Alnico V permanent magnet. In the case of the Cat. 1913 flow transmitter the field strength is developed by the output current flowing through the N turns of the field coil ($\Phi \propto Ni$). For the Cat. 1913 the feedback force is proportional to the square of the output current, since $F_C = K\Phi li = KNili = KNli^2$.

The effect of a differential pressure may be simulated by hanging gram weights (W) of predictable quantity on the weight calibration pulley.

Table IV lists the spread of input pressure spans in inches of water and grams per square inch, the effective diaphragm diameter and area, the total force on the diaphragm, the resulting torque on the diaphragm beam, and the corresponding weights used to simulate this torque during weight calibration. (Note that the moment arm of the diaphragm force is 3 inches below the beam pivot, while the moment arm of the calibrating weight is only 1.5 inches to the right of the beam pivot.)

21B. Weight Calibration

A threaded rod projects horizontally from the diaphragm beam and carries a factory-set pulley and hook for hanging span-calibration weights. Since the weights hang at a distance of 1.5 inches from the beam pivot, whereas the diaphragm force acts at a distance 3 inches from the pivot, the calibrating weight in grams must be twice the diaphragm force it represents, in order to produce the same torque on the beam. A standard 1000-gram weight is used for calibrating the highest span settings of Bands 2, 3, and 4, and 333 grams for Band 1. Table I lists calibrating weights for various band numbers and pressure settings.

21C. Zero Adjustment

Zero adjustment is achieved by spring-loading the coil beam. The zero springs are cemented to the coil beam close to its pivot. Their outer ends are screwed to a pivoted yoke which is rotated by turning the threaded zero-adjusting rod with a screwdriver. The rod has a left-hand thread; therefore, turning the rod clockwise lowers the brass stop and

allows the heavy spring to rotate the yoke clockwise, increasing the output current of the transmitter as the zero springs try to force apart the detector capacitor plates. The output may be adjusted to zero for any pressure input within ±50% of span.

The zero output of the transmitter is also affected by the length of the flexible link between the beams. The four screws on the link should always be firmly tight, and the Allen setscrews on the two clamps should be well tightened after changing the coarse span adjustment.

21D. Fine Span Adjustment

The method used for a trimming adjustment of the span is to change the average length of the air gap of the magnet which provides the field for the beam coil. This is done by using the threaded rod of the fine span adjustment to spread apart the top of the magnet assembly. This changes the flux density of the field around the coil, thereby changing the coil's feedback force for a given coil current. For example, lengthening the air gap weakens the field and requires the transmitter to send more output current through the feedback coil in order to balance the force on the diaphragm. The adjusting rod used to move the hinged magnet for this purpose is identified in Fig. 6. It is a screwdriver adjustment on the front panel. As the rod is turned clockwise the end of the rod pushes on the fixed part of the magnet and the threaded brass bushing in the pivoted part forces the gap wider, stretching the spring. The average flux density in the gap decreases, so more current is required through the coil to balance a given diaphragm force. A clockwise rotation of the fine span adjustment, therefore, increases the output current.

22. ELECTRONIC CIRCUITS

The purpose of the electronic portion of the transmitter is to produce a current whose magnitude varies in proportion to variations in the position of the diaphragm beam. To achieve this requires the use of a crystal-controlled oscillator and a d-c amplifier, which are located on a printed-circuit card in the lower compartment of the transmitter assembly. The complete circuit diagram is shown in Fig. 7.

Slight motion of the diaphragm beam (caused by changes of input pressure) varies the separation between the plates of position-detector capacitor C22, thereby changing the frequency of operation of the rf oscillator.

22A. Power Supply

The 120-volt 60 or 50 cycle line supplies the primary winding of the power transformer (T1). The full-wave rectified d-c voltage (measured between Test Points 5 and 4) supplies the output bridge circuit through connector points J1-10 and J1-12. The same d-c voltage is reduced through R9 and regulated with a 9-volt Zener diode, CR1, to supply the

oscillator and amplifier circuits. (Regulated voltage is measured between Test Points 1 and 4).

22B. Position Detector and Oscillator

The position detector for the balance system is a parallel-plate air capacitor C22. One plate is fixed to the support casting but insulated from it by a ceramic plate. The other plate, which is the grounded side, is mounted on the diaphragm beam and moves with it. Capacitor C22 is connected across the tank circuit of a transistorized, 1 megacycle crystal-controlled oscillator. One tank-circuit lead is connected to the insulated fixed plate; the other tank-circuit lead is connected to ground through the .02 μfd capacitor, C23. The .02 μfd capacity is very large compared with the normal 140 pf (.00014 μfd) capacity of C22; therefore, C23 has negligible effect on the oscillator circuit. The oscillator tank circuit consists of C22, C3, and rf tuning coil L2, which contains a factory-adjusted ferrite core.

22C. Oscillator and Demodulator

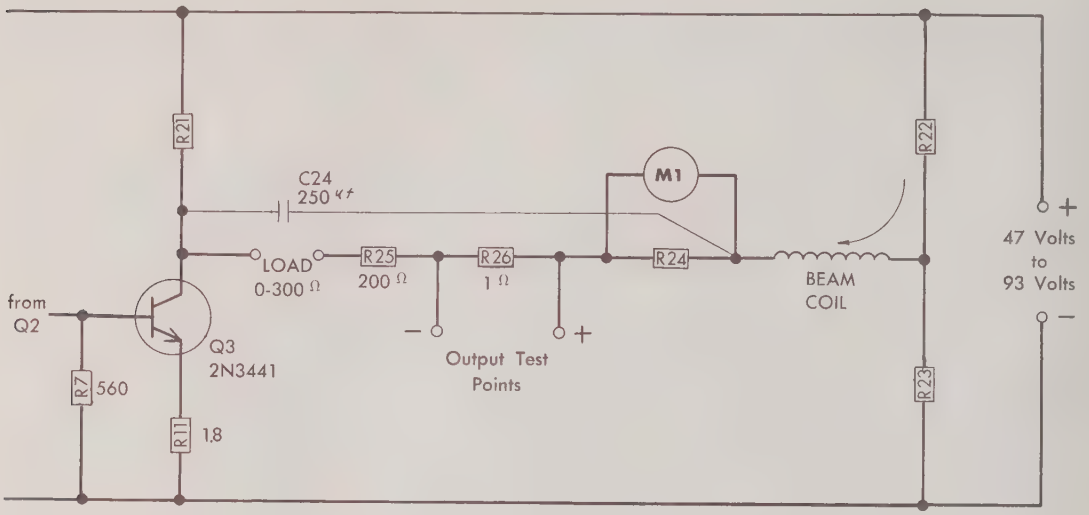
The amplitude of oscillation is very sensitive to the capacity between the position-detector plates, increasing as the plates move closer together. The average emitter current in Q1 increases with rf amplitude, which increases the rf voltage across R3. (To observe this, connect a suitable oscilloscope between Test Points 2 and 4.) The rf component of this voltage is coupled through C5 to diodes CR3 and CR4. CR3 clamps this voltage to the common bus (Test Point 4) and keeps the positive peaks constant at the clamping voltage. Therefore, any increase in rf amplitude makes the rf peaks at CR3 go more negative and increases the negative charge on C6 by isolating diode CR4.

22D. The D-C Amplifier

The charge on C6 determines the voltage on the base of transistor Q2, the first stage of a d-c amplifier. As this base voltage goes more negative, the emitter current through Q2 and R7 decreases; therefore, the voltage on the base of Q3 decreases. Capacitor C7 and resistor R8 serve as a damping circuit for the d-c signal. Output transistor Q3 forms one of four arms of an output bridge circuit illustrated in Fig. 10.

22E. The Output Bridge Circuit

Resistors R21, R22, R23, and transistor Q3 form a bridge across which a d-c voltage of 47 to 93 volts is applied to connectors J1-10 and J1-12. The circuit connected across the side junctions of this bridge comprises the external load, a padding resistor R25, calibration resistor R26, the meter, and the feedback coil. Capacitor C2 is used to damp the output signal. This may be replaced with a larger non-polarized electrolytic capacitor with 25-volt d-c rating if more output damping is required. Maximum damping effect from this capacitor will be obtained when the external load resistance is padded to the full maximum load resistance.



Output-Current Range	0 to 40 ma	10 to 50 ma	−20 to +20 ma
R21	1500 ohms, 5W, 5%	2500 ohms, 5W, 5%	700 ohms, 10W, 5%
R22	400 ohms, 10W, 5%	250 ohms, 10W, 5%	700 ohms, 10W, 5%
R23	2500 ohms, 5W, 5%	3000 ohms, 5W, 5%	400 ohms, 10W, 5%
Beam coil resistance is 3 ohms for sensitivity-band 1 and 26 ohms for sensitivity-bands 2, 3, and 4.			

Fig. 10—The 1912 Transmitter output bridge circuit.

When the base voltage of transistor Q3 decreases it raises the emitter-to-collector resistance of Q3, thus changing the voltage distribution in the bridge circuit. When the ratio between R21 and the emitter-to-collector resistance of Q3 is equal to the ratio between R22 and R23, the bridge is balanced. No current flows through the load circuit because voltages at the junctions are equal. Therefore, nominal collector-to-emitter resistance of transistor Q3 at balance for a 40 ma output range is

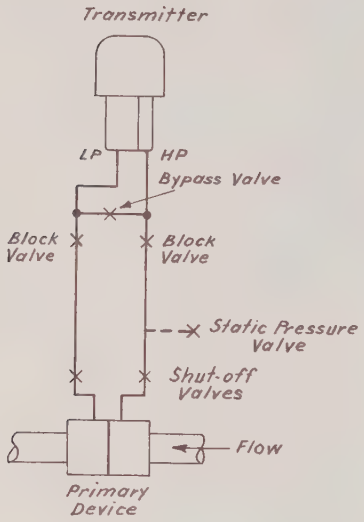
$$1500 \times \frac{2500}{400} = 9375 \text{ ohms.}$$

When Q3 resistance is less than this balance value, positive current (right to left) flows through the load circuit. When Q3 resistance is greater than this balance value, negative current (left to right) flows through the load circuit. Note that the table in Fig. 10 shows different values for R21, R22, and R23 for the different ranges of output signal. A 0 to 40 ma transmitter should not be used for 10 to 50 ma output, and cannot be used for −20 to +20 ma output, unless these three resistors are changed accordingly. Their location is shown in Fig. 8.

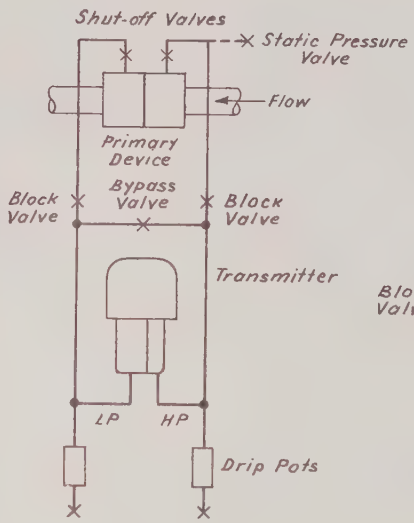
22F. Meter Circuit

The output indicating meter, an option to the standard transmitter,

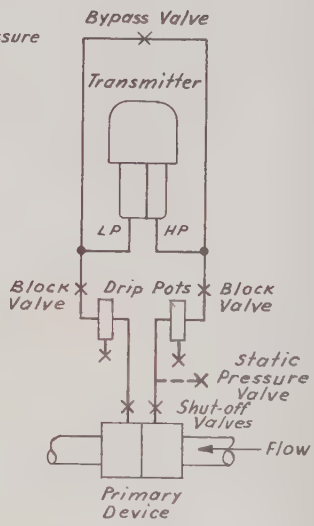
is a voltmeter having a 400 mv span and 400 ohms internal resistance. It is connected across a 10.256-ohm precision series resistor in the output circuit; therefore, a 40 ma change of output current produces full-scale deflection of this meter. A voltmeter connection, rather than a current meter is used so that possible meter failure will have no effect on the output signal.



A1–Self-draining layout which is recommended except where excessive moisture is present in gas.



A2–Layout recommended when transmitter must be mounted below the gas-flow piping run.



A3–Recommended layout for use where excessive moisture is present in the gas.

APPENDIX A

PIPING

A1. GENERAL RECOMMENDATIONS

(1) Keep the distance between primary devices and transmitter as short as possible. Distances exceeding 100 feet are not recommended. Use 1/4" tubing or piping.

(2) Slope all piping at least 1" per lineal foot to avoid liquid entrapment in lines or transmitter.

(3) If process media at temperatures exceeding 160 °F must be measured, provide 2 feet of uninsulated piping between transmitter and primary device for each 100 degrees in excess of 160 °F.

(4) When mounting the manifold, locate the block valves and bypass valves where they are readily accessible to the operator from the front of the transmitter. Use shut-off valves at the source of differential pressure.

A2. PIPING FOR GAS MEASUREMENT APPLICATIONS

Typical diagrams for special gas-measuring applications are shown in Figs. A1, A2, and A3. Use the diagram most suitable to your application as a guide. Be sure to connect the high-pressure side of the transmitter to the upstream tap of the primary device.

(1) In the typical piping layout of Fig. A1, the transmitter is placed above the gas-flow-piping run. This self-draining layout is recommended for use wherever possible except where excessive moisture may be present with the gas. If the latter is true, refer to (3) below.

(2) In the typical piping layout of Fig. A2, the transmitter is placed below the gas-flow-piping run. This layout should be used only when it is necessary to mount the transmitter below the run. When wet gas is present, drip pots are required as shown.

(3) In the piping layout of Fig. A3 the transmitter is mounted above the gas-flow-piping run in an arrangement recommended when excessive moisture is present with the gas. The bypass manifold is installed above the transmitter to avoid condensate build-up in the bypass which could run into the high and low pressure lines. Where unusually severe conditions exist, drip pots are used to trap condensate and help prevent plugging.

APPENDIX B

EXTERNAL LOAD REQUIREMENTS FOR SUM AND DIFFERENCE CIRCUITS

Because the 1912 Transmitter produces a current output rather than a voltage output, the external load requirements are very flexible. For example, all or part of the rated 300-ohm load may be shorted without significant effect on output current. In sum and difference applications, two or more transmitters may feed a common load resistor. Therefore, the voltage across this resistor represents the algebraic sum of all transmitter outputs. If this type of circuit is used, the maximum voltage across the common load resistor must not exceed the rated 12 volts. For example, a 40 ma output flowing through the rated 300-ohm external load produces the rated 12 volts. But if two transmitters supply this same output at the same polarity in a summing circuit, a total of 80 ma could flow through the common resistor and the rated voltage would be exceeded. To avoid this, use a load resistor not exceeding 150 ohms in this case. If three transmitters feed a common resistor with 40 ma in the same direction of flow, the resistance must not exceed 100 ohms or the voltage produced at maximum current of 120 ma will produce more than the rated 12 volts.

When output currents of opposite polarities are carried by a common resistor, the load resistance is limited only by the number of output currents of the same polarity. For example, if two transmitters are supplying opposite polarity output currents to the same external load for an output difference circuit, the maximum voltage of 12 volts occurs when the first transmitter has 40 ma output and the second has 0 output current. The load voltage is less under other conditions and is reduced to zero when the two output currents are equal.

Note that when this difference circuit is used with a 300-ohm load resistor and the first transmitter output approaches 40 ma, the design of the output circuits will not permit the output current of the second transmitter circuit to go to zero. That is, regardless of how much the resistance of Q3 is raised, the presence of a negative 12-volt signal across the output load of the second transmitter will cause a current of about 6 ma to flow through its output circuit. For this reason, the output current of the second transmitter cannot go below 1.5% of its output range when its input pressure goes to its low-end limit. That is, the second transmitter's output will not balance its differential input below this point. However, the output current will remain accurate until this point is reached and, since this error appears only at the zero end of the range, it is of little consequence. To avoid this condition, the user can simply minimize voltage shunting the output circuit of the second transmitter. This voltage is reduced, of course, if the output of the first transmitter does not approach 40 ma. It can also be reduced by decreasing the value

of the common load resistor (normally 300 ohms), which will reduce the output voltage. This 1.5% cut-off point will be decreased in proportion to the amount by which the 300-ohm load resistor is decreased. Another effect of this limiting condition is that the common load resistor appears to be shunted by the 2000-ohm circuit resistance of the second transmitter (R21, R22, the beam coil, R25, and R26), and when the maximum load resistance is used, the output voltage will be low by about 300/2000 or 15% of the reading. This condition can also be reduced in proportion to the amount by which the common load resistor can be reduced below 300 ohms. Apply this same reasoning to applications where more than two transmitter outputs are totalized.

It should be noted that when two or more transmitters are connected to a common load resistor, none of the transmitters can have their power turned off without causing an error in the voltage signal across the common resistor. This is because the output bridge circuit of any turned-off transmitter will appear as a resistive shunt across the common load resistor and reduce its effective resistance. However, disconnecting the plug-in cable from such a transmitter will not cause any error in the output voltage of other transmitters connected to the same load resistor, since the internal bridge circuit is then disconnected at the same time as the line voltage.

APPENDIX C

FIELD CONVERSION PARTS AND PROCEDURES

C1. TO CONVERT TO NEW SPAN-ADJUSTMENT BAND OR OUTPUT

The following list identifies by catalog number transmitter parts which differ from one 1912 Transmitter to another according to their band of input-pressure spans and output current ranges. Use this table to order parts for converting your instrument to the desired band of span adjustment and current range.

CATALOG NUMBER *	SPAN ADJUST	PARTS FOR CHANGING BAND OF SPANS		PARTS FOR CHANGING OUTPUT CURRENT RANGE					REFERENCE ONLY
	inches of water	Diaphragm Assembly	Feedback Coil	Output Current	Output Panel▲	Resistors▲ R21	R22	R23	Coil-Beam Assembly
1912-1-10, -11	0.2-1	133063	115126	0-40	124524	011478	311175	011914	115161
1912-1-20, -21	0.2-1	133063	115126	10-50	124525	011914	311272	311273	115161
1912-1-30, -31	0.2-1	133063	115126	-20 to +20	124526	311176	311176	311175	115161
1912-2-10, -11	0.6-3	133063	115125	0-40	124524	011478	311175	011914	115160
1912-2-20, -21	0.6-3	133063	115125	10-50	124525	011914	311272	311273	115160
1912-2-30, -31	0.6-3	133063	115125	-20 to +20	124526	311176	311176	311175	115160
1912-3-10, -11	1.2-6	133064	115125	0-40	124524	011478	311175	011914	115160
1912-3-20, -21	1.2-6	133064	115125	10-50	124525	011914	311272	311273	115160
1912-3-30, -31	1.2-6	133064	115125	-20 to +20	124526	311176	311176	311175	115160
1912-4-10, -11	4-20	133065	115125	0-40	124524	011478	311175	011914	115160
1912-4-20, -21	4-20	133065	115125	10-50	124525	011914	311272	311273	115160
1912-4-30, -31	4-20	133065	115125	-20 to +20	124526	311176	311176	311175	115160

*Only the first and second sufixes of the catalog numbers are shown. If second suffix is 11, 21, or 31, meter 021055 is used; if it is 10, 20, or 30, no meter is used.

▲ When changing the output current range, order either an entire new output panel or a new set of resistors to be substituted for those on the present panel. Do not order both panel and resistors.

C2. TO ADD OUTPUT-CURRENT METER

The following parts are needed to add the output meter to your transmitter. Select the proper meter. The stud screws onto the upper-left meter-screw and is locked by a #4-40 nut supplied. The bumper screws into the stud and touches the casting. It is locked by a #8-32 nut, also supplied. Remove the plug button from the three holes in the panel in order to mount the meter bracket. Refer to the wiring diagram on the right side of Fig. 8 to locate the mounting of resistor R24. Remove the jumper and solder the resistor in place.

Meter Kit	124528
Meter	
0-40 ma	021055
10-50 ma	021095
-20 +20 ma	021094
Cover Casting with window	067953
Stud	061466
Bumper	041002

C3. TO CONVERT TO A 1913 FLOW TRANSMITTER

In the column headed "1913" are the new parts required to convert the 1912 Differential Pressure Transmitter to a 1913 Flow Transmitter. In the column headed "1912" are the corresponding parts they will replace. If necessary, convert to new input pressure range in accordance with Appendix C1.

DESCRIPTION	1913 PART NO.	1912 PART NO.
Zero Springs (2)	028321	028322
Electromagnet	080066	080065
Feedback Coil		
Bands 2, 3, & 4	115127	115125
Band 1	115128	115126
Output Panel	124527	See App. C1
R25 Resistor	311175	- - - -
Front Nameplate	269091	269050
Data Nameplate	187503	187502
Eastman 910 Cement	804060	804060
Gasket for Nameplate	096319	096319
Directions	177444	177446

Proceed as follows:

(1) Remove the top cover casting and the casting which holds the nameplate.

(2) Disconnect the cable and remove the output panel.

(3) Remove the feedback coil and its magnet.

(4) Remove the zero springs. Refer to Part IV of Directions 177444 for mounting the new parts and calibrating the flow transmitter.

(5) Remove the nylon cord from the 1912 nameplate and fasten it under the adhesive gasket on the 1913 nameplate.

(6) Cement the zero springs to the beam, using 804060 cement.

Recommended spare parts for the 1913 Transmitter are the same ones listed in Section 20 for the 1912 Transmitter.

L&N FIELD OFFICES

ALA., *Birmingham*
ARIZ., *Phoenix*
CAL., *Los Angeles* [*Monterey Park*]
CAL., *San Francisco*
COLO., *Denver*
CONN., *West Hartford*
DEL., *Wilmington*
D.C., *Washington* [*Silver Spring, Md.*]
FLA., *Orlando*
GA., *Atlanta*
ILL., *Chicago* [*Park Ridge*]
ILL., *Lansing*
IND., *Indianapolis*
IOWA, *Davenport* [*Bettendorf*]
LA., *Baton Rouge*
MD., *Baltimore* [*Silver Spring*]
MASS., *Boston* [*Dedham*]
MICH., *Detroit*
MICH., *Grand Rapids*
MINN., *Minneapolis*
MO., *Kansas City*
MO., *St. Louis* [*Clayton*]
NEB., *Omaha*
N.J., *East Orange*
N.Y., *Albany* [*Latham*]
N.Y., *Buffalo*
N.Y., *New York*
N.Y., *Syracuse*
N.C., *Winston-Salem*
OHIO, *Canton*
OHIO, *Cincinnati*
OHIO, *Cleveland*
OHIO, *Columbus*
OHIO, *Dayton*
OHIO, *Toledo*
OKLA., *Tulsa*
PA., *Bethlehem*
PA., *Harrisburg*
PA., *Philadelphia* [*Fort Washington*]
PA., *Pittsburgh*
TEXAS, *Dallas*
TEXAS, *Houston*
UTAH, *Salt Lake City*
VA., *Richmond*
WASH., *Seattle*
W. VA., *Charleston*
WISC., *Milwaukee*

Main Offices, 4901 Stenton Ave., Philadelphia, Pa. 19144
Plants: Philadelphia & North Wales, Pa.

Leeds & Northrup, Canada, Ltd., 41 Constellation Court, Rexdale (Toronto), Ontario
Field Offices: 465 Victoria Ave., St. Lambert (Montreal), Quebec
928 6th Avenue S.W., Calgary, Alberta

Leeds & Northrup, Ltd., Wharfdale Road, Tyseley, Birmingham 11, England
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